No. 25

ADDENDA TO

OFFICE OF MANNED SPACE FLIGHT

MANNED LUNAR LANDING PROGRAM MODE COMPARISON (Addenda)

[U]

23 June 1962

National Aeronautics and Space Administration
Office of Manned Space Flight
Office of Systems
Washington, D. C.

[redacted]

A D D E N D A

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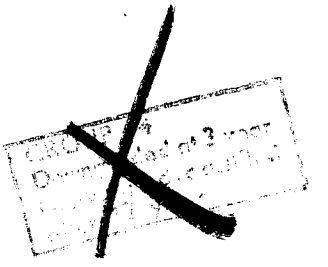

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INTRODUCTION

The material in these Addenda have been generated by the Office of Manned Space Flight, Marshall Space Flight Center, Manned Spacecraft Center and Launch Operations Center to be used in conjunction with mode selection. The information furnished should be used for mode selection only. After this has been done a much more complete planning cycle will be required for the selected mode to establish the necessary realistic operating plans, schedules, and resource requirements.

The following is a memorandum from D. Brainerd Holmes, Director, Manned Space Flight, NASA Headquarters; to Directors of Launch Operations Center, Manned Spacecraft Center, and Marshall Space Flight Center; dated May 25, 1962.

Subject: The Manned Lunar Landing Program

As part of the current study to determine the primary mode for manned lunar landing, it is essential that we have schedule and cost information from the Field Centers on the three modes under consideration.

This memorandum constitutes the first call for schedules to be submitted in accordance with the Office of Manned Space Flight Scheduling Procedures forwarded to you by memorandum dated 19 April 1962.

Using the March 19 schedule submission from MSC and MSFC, the OMSF staff has prepared cover schedules (attachment #1) to include the mission to be accomplished on each flight for each mode (LOR, EOR, and DF). It is desired that you prepare a package for each mode with component schedules which will make available the hardware and facilities to support these schedules and cost out (through FY 1967) each of the modes in accordance with instructions.

To insure consistency in the submissions from each Center and to permit an analysis by the OMSF staff among the modes, no deviation will be made to the cover schedules or missions in the preparation of your package. However, after the package has been completed, in Part II of the format for the OMSF Scheduling Procedures, it is requested that you make an evaluation of the cover schedules (attachment #1) as to the possibilities of achievement, major problem areas, recommendations for deviations, etc.

The following additional guidelines are included to assist in the preparation of the packages:

a. The C-8 vehicle in the Direct Flight mode will use the following engine configuration: (8 F-1, 8 J-2, 1 J-2).

b. The supporting milestone development schedules to the attached cover schedules will include:

(1) First level -

(a) C-1
(b) C-1b
(c) C-5
(d) C-8
(e) Spacecraft for all three modes

(2) Second level -

(a) All stages for launch vehicles
(b) All modules for spacecraft

(c) Spacecraft propulsion units
(d) Guidance
(e) Ground Support Equipment
(f) Critical facilities associated with scheduled item
(g) Engines for launch vehicles

c. No funding limitation will be assumed when costing out of each of the packages.

d. It will be assumed that the Gemini communications net will be available for any mode requiring its use.

e. Payload adapters will be the responsibility of MSC and nose cones the responsibility of MSFC.

f. Ground instrumentation, tracking and data acquisition requirements that are physically located at the Cape will be prepared by L.O.C. under the heading of Range Instrumentation. All requirements in this area, other than those located at the Cape, will be prepared by MSC under the heading of Tracking and Data Acquisition.

g. In addition to determining the cost of the three packages, it is desired that you show a break out of the average cost (excluding development) of conducting an operational mission to include:

(1) Average unit cost of each module and each launch vehicle

(2) Procurement lead time required for each module and each launch vehicle

(3) The ground and flight operations costs associated with the flight

h. MSFC should also include a proposed schedule and a summary of costs for the NOVA launch vehicle. The engine configuration for the NOVA vehicle will be 8 F-1, 2 M-1, 1 J-2.

Attachment #3 is the ground rules that were used by the OMSF staff in the preparation of the cover schedules and are forwarded for your information.

These schedules are not intended to represent dates by which individual missions will be accomplished, but rather the dates by which mission hardware will be available. Since the cover schedules will be used as an input to the determination of the primary mode, there will be some conflict with the criteria in the OMSF Scheduling Procedures. The following deviations are approved:

a. Revisions, changes, and Status Reports - because this exercise is for planning purposes only and contains modes which we may not pursue, revisions, changes, and Status Reports will not be submitted unless specifically requested by future correspondence.

b. Coordination - coordination is encouraged among the Centers but it is recognized that the amount of coordination may be limited by the time available to meet the submission date of the package.

c. Total Funds - will be included, but will be based on total requirements for a "success" schedule, rather than approved funding.

d. Current Year Funding and Current Year Manpower - the information will not be shown for this call.

The completed package will be due at the OMSF by June 15, 1962.

Questions concerning these instructions or the OMSF Scheduling Procedure should be directed to Plans and Reports Office (MPRP) Telephone DU 2-3124.

GROUND RULES FOR THE PREPARATION OF COVER SCHEDULES

1. The schedules were prepared to define the earliest possible points at which vehicle and spacecraft components would be required.

2. Fully-loaded earth orbital tests are not required prior to manned lunar landing attempts.

3. Circumlunar and lunar orbit tests are not required prior to manned lunar landing attempts.

4. At least two unmanned tests of each propulsion module to be accomplished prior to any manned flight.

5. Two tests of each propulsion module to be accomplished prior to total spacecraft systems tests. (Spacecraft systems required for the manned lunar attempt.)

6. Three unmanned tests of the total spacecraft and vehicle system were planned prior to the manned lunar attempt. (Unmanned landing or unmanned rendezvous not required.)

7. For EOR and LOR three manned rendezvous tests on C-1b were planned prior to a manned lunar landing attempt.

8. Two circular reentry tests to be accomplished prior to manned orbital flight on C-1.

9. Three "super circular" reentry tests to be accomplished on C-1b. (Peak heating rate and maximum total heat.)

10. Two parabolic reentry tests were planned prior to a manned lunar attempt on C-5 for EOR and LOR and C-8 on DF.

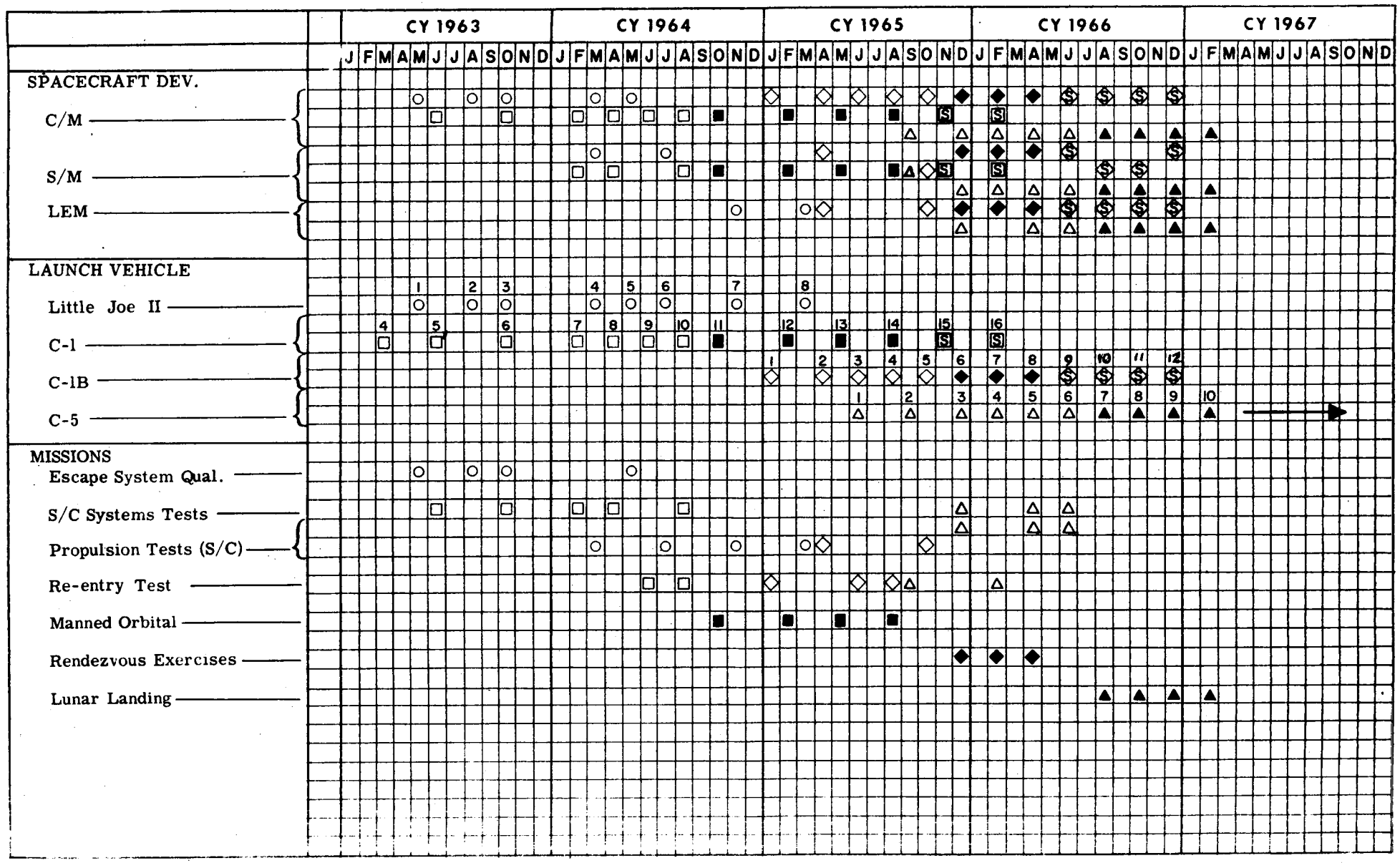
Attachment #3

ADDENDUM 2A - TOP SCHEDULES

CONFIDENTIAL

TITLE Schedule for LOR (C-1, C-1b and C-5)

□ – Unmanned
■ – Manned
S – Spare



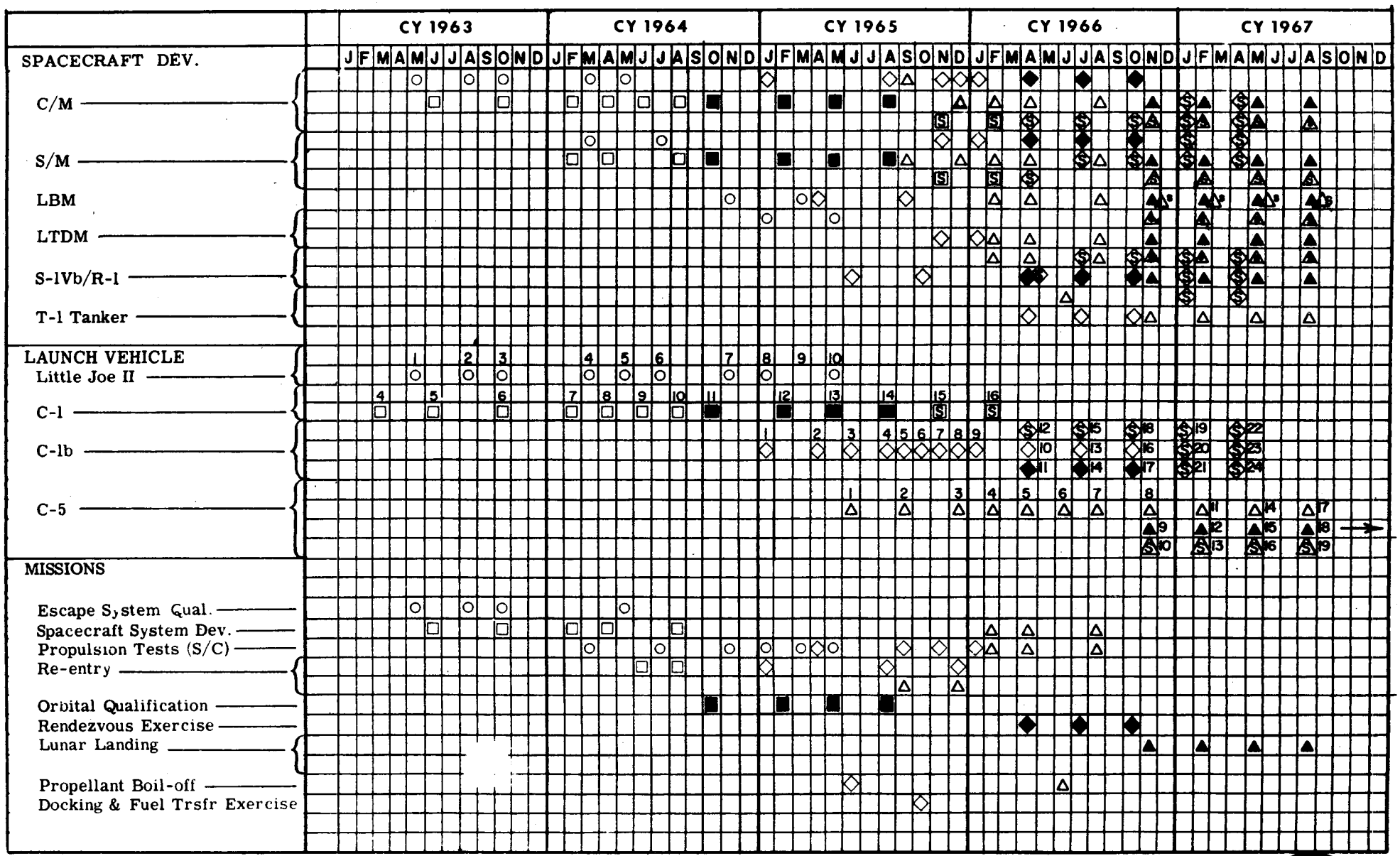
Attachment 1

CONFIDENTIAL

~~CONFIDENTIAL~~

TITLE Schedule for EOR (C-1, C-1b and C-5)

□ - Unmanned
■ - Manned
S - Spare



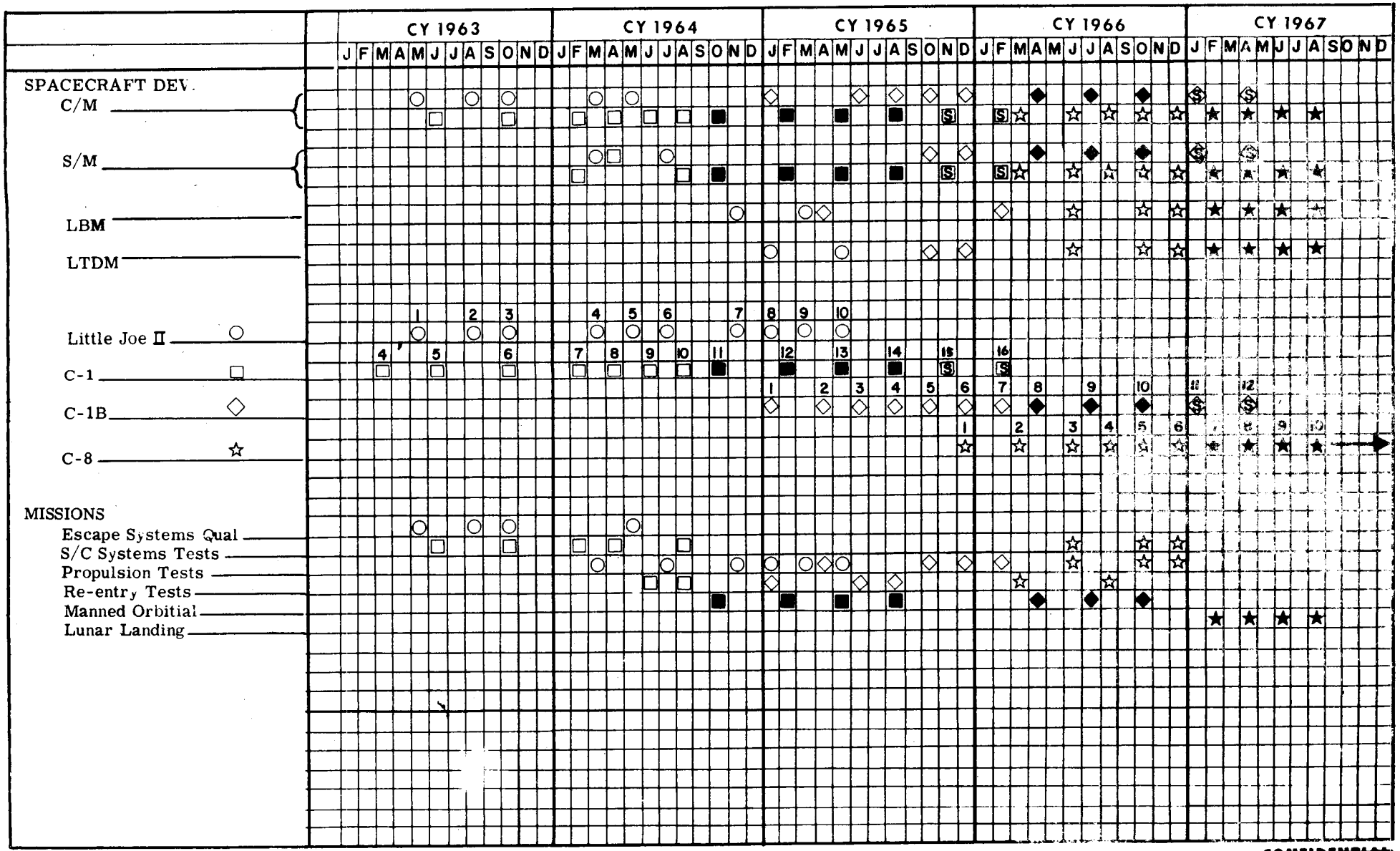
Attachment 1

~~CONFIDENTIAL~~

[redacted]

TITLE Schedule for Direct Flight (C-1, C-1b and C-8)

□ - Unmanned
■ - Manned
S - Spare



Attachment 1

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ADDENDUM 2B - CENTER COMMENTS AND CRITIQUES ON TOP SCHEDULES

In response to the directive of May 25, 1962, Marshall Space Flight Center, Manned Spacecraft Center, and Launch Operations Center complied by submitting the requested information set forth in the memorandum.

Important excerpts from their responses are given on the following pages, referring to the documents listed below:

George C. Marshall Space Flight Center, Huntsville, Alabama,
M-CP-R10, June 15, 1962.
MSFC CONSOLIDATED [illegible] MANNED LUNAR LANDING PROGRAM MODE COMPARISON

Manned Spacecraft Center, Houston 1, Texas.
MANNED LUNAR LANDING PROGRAM MODE COMPARISON SCHEDULES AND FUNDING

Launch Operations Center
MANNED LUNAR LANDING PROGRAM MODE COMPARISON PROGRAM SCHEDULES AND FUNDING

NOTE: Pages referred to in the following comments are page numbers in the above publications.

EARTH ORBITAL RENDEZVOUS (EOR)
MSFC COMMENTS AND CRITIQUE

I. C-1 LAUNCH VEHICLE: (See p. 51)

The basic schedule is sound and although development difficulties in the S-IV stage and vehicle integration will cause minor delays in 1963 and 1964, the major objectives in 1965 can be attained.

II. C-1B LAUNCH VEHICLE (See p. 57)

A. Present analysis indicates the proposed vehicle schedule is unrealistic in the order of four to six months for the following reasons:

1. Neither the engine nor the facility required for the S-IVB battleship testing to start July 1963 is on order.
2. It does not appear realistic to assume that the S-IVB program can have early utilization of Sacramento Test Stands 1 or 2b scheduled for use in the S-IVB project.
3. The PFRT of the J-2 engine has slipped from February 1963 to October 1963.
4. It has taken more than 24 months from contract to start battleship testing in the S-IV stage project. It is improbable that this time can be cut in half for the S-IVB stage.
5. First S-IVB stage would require automatic checkout capability.

B. In the Flight and Mission Schedule, S-IVB/R-1's are only shown on two of the first none C-1B flights. S-IVB/R-1's should be part of every C-1B vehicle.

C. The primary mission objective of the early launches of C-1B is the development of the launch vehicle and of the S-IVB stage for C-5. Secondary mission objectives should be considered on an optional, non-interference basis.

D. It could not be determined within the time frame of this study whether the individual flight missions specified by OMSF are acceptable for technical and flight performance reasons. Further study is required prior to formal mission approval.

III. C-5 LAUNCH VEHICLE: (See p. 64)

A. The accelerated C-5 program, as presented in the foregoing pages, is considered a high risk program. Conditions which introduce the risk element in the development program are outlined below:

1. Introduction of additional hardware into the MSFC manufacturing program as well as acceleration of the ground test program items require the utilization of double shifts and considerable overtime in the shaps as an integral part of the basic program.

2. The MTF test facility will not be available in time for acceptance testing of SA-501 and SA-502 under the accelerated first launch of June 1965. This means that the R&D static test facility at MSFC will have to be utilized for these flight vehicles four months earlier than presently planned. Under these conditions, the R&D battleship testing program at MSFC will be reduced to approximately five months.

3. The completion of the facility checkout stage cannot be accelerated, therefore, the advancement of the first launch by four months (June 1965) will reduce VLF-39 checkout time from eight to four months.

4. C-5 vehicle advancement reduces flight experience to be gained from C-1B.

5. As the flight development program meets with difficulties, as will come about in a vehicle of the C-5 type, re-scheduling will, by necessity, have to divert primary missions from operational use to vehicle development. MSFC recommends a minimum of 10 vehicle R&D flights prior to manned application.

B. The automated GSE development must be carried out concurrently with the vehicle development because of the intricate relation of component design, automated sensing, etc. Present MSFC plans for GSE are made on this basis. However, any change that might cause a re-direction-delay in definition, or otherwise hold up the orderly procedure of vehicle and GSE design would immediately have an adverse effect on the schedule. The impact would have to be assessed after such policy definitions are known.

C. The scheduled availability of the Michoud facilities would require a change in present plans in that manufacture of the first flight S-IC stage will have to be at MSFC in a joint MSFC-Boeing effort.

IV. ENGINE DEVELOPMENT PROGRAM (See p. 67)

A. Delivery of J-2 engines cannot be accomplished to meet the requirement for ground test engines in April 1963 for C-1B (S-IVB stage) and May 1963 for C-5 (S-II stage).

B. In order to have meet these requirements, a contract should have been initiated in early May 1962. (Twelve months lead time is required for the production and delivery of J-2 engines.) Funds in the amount of $4.645 million ($2.345 million above that approved) would have been required in early May 1962 (FY 1962).

C. Delivery of J-2 flight engines for C-1B only three months after PFRT is marginal because of the required early release of engine parts and the short time to correct problems that may show up during PFRT.

EARTH ORBITAL RENDEZVOUS (EOR)
MSC CRITIQUE

1. LTDM contract let (July 1962) - Predicated on July 1, 1962, decision date and change to NAA contract to include LTDM.

2. LBM contract let (October 1962) - Predicated on July 1962 request for competitive proposals.

3. CM and SM design release (April 1963) - A slip of four months is currently indicated.

4. Manufacturing complete, first CM and SM (October 1963) - A slip of four months is currently indicated.

5. Design release LTDM (December 1963) - Predicated on significant application of service module design.

6. Design release for LBM (March 1964) - Predicated on utilization of existing engines.

7. First manned CM and SM (October 1964) - A slip of six months is currently estimated.

8. CM and SM development and qualification complete (January 1966) - The adequacy of the time interval between milestones 7 (March 1964) and 8 (October 1964) requires further study even if optimum launch vehicle availability is assumed.

9. LTDM development and qualification complete (July 1966) - This milestone denotes completion of unmanned tests. Manned operation of the LTDM in earth orbit is felt to be required prior to lunar landing. A slip of four months is estimated to accomplish two manned LTDM tests using the C-5 launch vehicle.

10. LBM development and qualification complete (September 1966) - Milestone denotes completion of unmanned tests. Manned operation of the LBM in earth orbit is felt to be required prior to launch lunar landing. A slip of four months is estimated to accomplish two manned LBM tests using the C-5 launch vehicle.

11. Rendezvous development complete - Completion of rendezvous development in three flights may be overly optimistic.

12. First lunar landing (December 1966) - It is estimated that accumulated spacecraft development delays will result in a ten-month slip in this milestone - Four months as indicated for milestone 20 and an additional slip of six months is incurred when C-1B flights are scheduled at two-month intervals. The C-1B schedule specified for EOR is inconsistent with the other modes. Support of the specified C-1B rate (1 per month) with spacecraft is not realistic.

EARTH ORBITAL RENDEZVOUS (EOR)
LOC SUMMARY OF ASSUMPTIONS AND GUIDELINES

1. Complex 39 with 6 bays and 4 pads will be required in the space program whether LOR or EOR mode is selected.

2. C-1B will be launched from complex 37 and 34 provided the C-1 launches do not exceed 10 per year. Complex 39 will be used if C-1 launches exceed 10 per year.

3. Parameters and major components for complex 39 must be defined by 15 July 1962 in order to meet the first scheduled C-5 launch in June 1965.

4. In order to meet the first launch date, instructions to do so must be provided by 1 July 1962 so that concentrated effort may be applied. This will be necessary in order to provide launch facilities which are likely to be a major problem area.

DIRECT APPROACH (DA) - USING SATURN C-8
MSFC COMMENTS AND CRITIQUE

I. C-1 LAUNCH VEHICLE: (See p. 82)

The basic schedule is sound and although development difficulties in the S-IV stage and vehicle integration will cause minor delays in 1963 and 1964, the major objectives in 1965 can be attained.

II. C-1B LAUNCH VEHICLE: (See p. 87)

A. Present analysis indicates the proposed vehicle schedule is unrealistic in the order of four to six months for the following reasons:

1. Neither the engine nor the facility required for S-IVB battleship testing to start July 1963 is on order.

2. It does not appear realistic to assume that the S-IVB program can have early utilization of Sacramento Test Stands 1 or 2b scheduled for use in the S-IV project.

3. The PFRT on the J-2 engine has slipped from February 1963 to October 1963.

4. It has taken more than 24 months from contract to start battleship testing in the S- IV stage project. It is improbable that this time can be cut in half for the S-IVB stage.

B. The primary mission objective of the early launches of C-1B is the development of the launch vehicle and of the S-IVB stage for C-5. Secondary mission objectives should be considered on an optional, non-interference basis.

C. It could not be determined within the time frame of this study whether the individual flight missions specified by OMSF are acceptable for technical and flight performance reasons. Further study is required prior to formal mission approval.

III. C-8 LAUNCH VEHICLE: (See p. 93)

A. The schedule shown is considered optimistic even with the assumptions listed (see p. 88). It is a success schedule in which nothing goes wrong, all technical judgments are correct, and there are no failures. The six (6) vehicle R&D program is extremely undesirable considering the jump in technology from Saturn C-1 to C-8.

B. The decisions required (see p. 88) on July 1, 1962, to meet the schedule cannot be made without a major change in NASA policy and without a complete disruption of the Apollo program and the thousands of personnel now doing productive work towards the mission objective. A major redirection at this time would cause considerable delays in the schedule to bring C-8 to the same status that C-5 has today.

C. Based on past experience at MSFC in implementing programs of this magnitude, it is estimated that the first C-8 flight could take place in May 1967. This allows for the time required to stop the presently approved C-5 program and to define the C-8 program in sufficient detail that decisions can be made, facilities can be started and the contractors can be given sufficient information to start the stage development. Considering the technical uncertainties in the C-8 development, a 10 vehicle R&D program is almost mandatory although secondary missions could be flown starting on flight No. 6. Manned flights should not be considered prior to No. 11 in March 1969.

D. It is recommended that the basic C-8 configuration be changed to use 9 J-2 engines in the second stage instead of the 8 engines. This change does not delay the schedule and increase the cost only slightly, however, it does provide for engine out capability in the second stage. It is estimated that the inherent reliability of that stage could be improved from .818 to .923 with engine out.

IV. ENGINE DEVELOPMENT PROGRAM: (See p. 96)

A. Delivery of J-2 engines cannot be accomplished to meet the requirements for ground test engines in April 1963 for C-1B (SIVB stage) and May 1963 for C-8 (second stage).

B. In order to have met these requirements a contract should have been initiated in May 1962. (Twelve months lead time is required for the procurement and delivery of J-2 engines). Funds in the amount of $4.645 million ($2.345 million above that approved) would have been required in early May 1962 (FY-62).

C. Delivery of J-2 flight engines for C-1B only 3 months after PFRT is marginal because of the required early release of engine parts and the short time to correct problems that may show up during PFRT.

DIRECT APPROACH (DA)-USING SATURN C-8
MSC CRITIQUE (See p.7)

1. LTDM contract let (July 1962) - Predicated on July 1, 1962, decision date and change to NAA contract to include LTDM.
2. LBM contract let (October 1962) - Predicated on July 1962 request for competitive proposals.
3. CM and SM design release (May 1963) - A slip of four months is currently indicated.
4. Manufacturing complete, first CM and SM (October 1963) - A slip of four months is currently indicated.
5. Design release LTDM (December 1963) - Predicated on significant applicability of SM design.
6. Design release LBM (March 1964) - Predicated on utilization of existing engines.
7. First manned CM and SM flight (October 1964) - A slip of six months is currently estimated.
8. LTDM development and qualification complete (November 1966) - This milestone denotes completion of unmanned tests. Manned operation of the LBM would seem desirable prior to lunar landing. A slip of four months is estimated to accomplish two manned LTDM tests using the C-8 launch vehicle.
9. LBM development and qualification complete (December 1966) - Milestones denotes completion of unmanned tests. Manned operation of the LBM would seem desirable prior to lunar landing missions. It is assumed that these flights could be accomplished during the two additional C-8 flights for milestone 20 (LTDM development and qualification complete).
10. First lunar landing (February 1967) - It is estimated that spacecraft development delays will result in a four months slip in this milestone.

DIRECT APPROACH (DA)-USING SATURN C-8
LOC SUMMARY OF ASSUMPTIONS
AND GUIDELINES

1. C-1B will be launched from complex 37 and 34 providing the C-1 launches do not exceed 10 per year. Complex 39 will be used to launch C-1B if the C-1 launches exceed 10 per year.

2. Parameters and major components for the C-8 complex must be defined by 15 July 1962 in order to meet the first scheduled C-8 launch in December 1965. This is necessary in order to provide launch facilities which are likely to be a major problem area.

LUNAR ORBITAL RENDEZVOUS (LOR)
MSFC COMMENTS AND CRITIQUE

I. C-1 LAUNCH VEHICLE: (See p.22)

The basic schedule is sound, and although development difficulties in the S-IV Stage and vehicle integration will cause minor delays in 1963 and 1964, the major objectives in 1965 can be attained.

II. C-1B LAUNCH VEHICLE: (See p.27)

A. Present analysis indicates the proposed vehicle schedule is unrealistic in the order of 4-6 months. The reasons follow:

1. Neither the engine nor the facility required for S-IVB battleship testing to start July 1963 is on order.

2. It does not appear realistic to assume that the S-IVB program can have early utilization of Sacramento test stands No. 1 or 2b scheduled for use in the S-IV project.

3. The PFRT of the J-2 engine has slipped from February 1963 to October 1963.

4. It has taken more than 24 months from contract to start battleship testing in S-IV stage project. It is improbable that this time can be cut in half for the S-IVB stage.

B. The C-1B capability to launch a CM, SM and LEM is marginal. It is felt that certain compromises in the payload weights will be necessary to meet the proposed mission schedule. Further studies are definitely necessary prior to formal mission approval.

C. The primary mission objective of the early launches of C-1B is the development of the launch vehicle and of the S-IVB Stage for C-5. Secondary mission objectives should be considered on an optional, non-interference basis.

III. C-5 LAUNCH VEHICLE: (See p.33)

A. The accelerated C-5 program is considered a high risk program. Conditions which introduce the risk element in the development program are outlined below:

1. Introduction of additional hardware into the MSFC manufacturing program as well as acceleration of the ground test program items require the utilization of double shifts and considerable overtime in the shops as an integral part of the basic program.

2. The MTF test facility will not be available in time for acceptance testing of SA-501 and SA-502 under the accelerated first launch of June 1965. This means that the R&D static test facility at MSFC will have to be utilized for these flight vehicles four months earlier than presently planned. Under these conditions, the R&D battleship testing program at MSFC will be reduced to approximately five months.

3. The completion of the facility checkout stage cannot be accelerated, therefore, the advancement of the first launch by four months (June 1965) will reduce VLF-39 checkout time from eight months to four months.

4. C-5 vehicle advancement reduces flight experience to be gained from C-1B.

5. As the flight development program meets with difficulties, as will come about in a vehicle of the C-5 type, re-scheduling will, by necessity, have to divert primary missions from operational use to vehicle development. MSFC recommends a minimum of 10 vehicle R&D flights prior to manned application.

B. The automated GSE development must be carried out concurrently with the vehicle development due to the intricate relation of component design, automated sensing, etc. Present MSFC plans for HSE are made on this basis. However, any change which might cause a re-direction, delay in definition, or otherwise hold up the orderly procedure of vehicle and GSE design would immediately have an adverse effect on the schedule. The impact would have to be assessed after such policy definitions are known.

C. The scheduled availability of the Michoud facilities would require a change in present plans in that manufacture of the first flight S-IC stage will have to be at MSFC in a joint MSFC-Boeing effort.

IV. ENGINE DEVELOPMENT PROGRAMS (See p.36)

A. Delivery of J-2 engines cannot be accomplished to meet the requirement for Ground Test Engines in April 1963 for C-1B (S-IVB) stage and May 1963 for C-5 (S-II stage).

B. In order to have met these requirements a contract should have been initiated in early May 1962. (Twelve months lead time is required for the procurement and delivery of J-2 engines.) Funds in the amount of $4.645 million ($2.345 million above that approved) would have been required in early May 1962 (FY-62).

C. Delivery of J-2 flight engines for C-1B only 3 months after PFRT is marginal because of the required early release of engine parts and the short time to correct problems that may show up during PFRT.

LUNAR ORBITAL RENDEZVOUS (LOR)
LOC SUMMARY OF ASSUMPTIONS
& GUIDELINES

1. Complex 39 with 6 bags and 4 pads will be required in the space program whether the LOR or EOR mode is selected.
2. C-1B will be launched from complex 37 and 34 provided the C-1 launches do not exceed 10 per year. Complex 39 will be used if C-1 launches exceed 10 per year.
3. Parameters and major components for complex 39 must be defined by 15 July 1962 in order to meet the first scheduled C-5 launch in June 1965.
4. In order to meet the first launch date, instructions to do so must be provided by 1 July 1962 so that concentrated effort may be applied. This will be necessary in order to provide launch facilities which are likely to be a major problem area.

LUNAR ORBITAL RENDEZVOUS (LOR)
MSC CRITIQUE (See p.5)

1. LEM contract let (October 1962) - Predicated on July 1962 competitive RFP.
2. CM and SM design release (April 1963) - A slip of four months is currently indicated.
3. Manufacturing complete, first CM and SM (October 1963) - A slip of four months is currently indicated.
4. LEM design release (March 1964) - Design release sixteen months after contract award may be overly optimistic.
5. Manufacturing complete, first LEM (August 1964) - Assumes maximum concurrency between design and manufacturing. Potential slip of six months is estimated.
6. The first manned CM and SM flight (October 1964) - A slip of six months is currently estimated.
7. The first manned LEM flight (December 1965) - The scheduled date appears possible of achievement from a time standpoint assuming optimum launch vehicle availability and disregarding the specified mission schedule. A slip of three months should be anticipated.

8. The CM and SM development and qualification complete (March 1966) - The adequacy of the time interval between first manned CM and SM flight (October 1964) and CM and SM qualification complete (March 1966) requires further study even if optimum launch vehicle availability is assumed.

9. LEM development and qualification (May 1966) - The indicated time interval between first manned LEM flight (December 1965) and LEM development and qualification (May 1966) is inadequate as is the number of specified flights. A minimum of five manned LEM flights over a time period of twelve months may be necessary.

10. First lunar landing (August 1966) - It is estimated that accumulated spacecraft development delays will result in a nine month slip in this milestone assuming optimum launch vehicle availability.

ADDENDUM 2C - INTRODUCTORY REMARKS TO REVISED SCHEDULES

The top schedules issued by OMSF on May 25, 1962, have been revised to reflect the comments and recommendations submitted by the Centers on June 15, 1962. Extracts from the Centers' comments and recommendations are summarized in Addendum B of this report. The major factors contributing to the revised schedules may be categorized as follows:

a) Delays in hardware availability for first vehicle flights.
b) Increase in number of R&D flight requirements.
c) Requirements for manned verification flights on operational hardware prior to first lunar landing attempt.

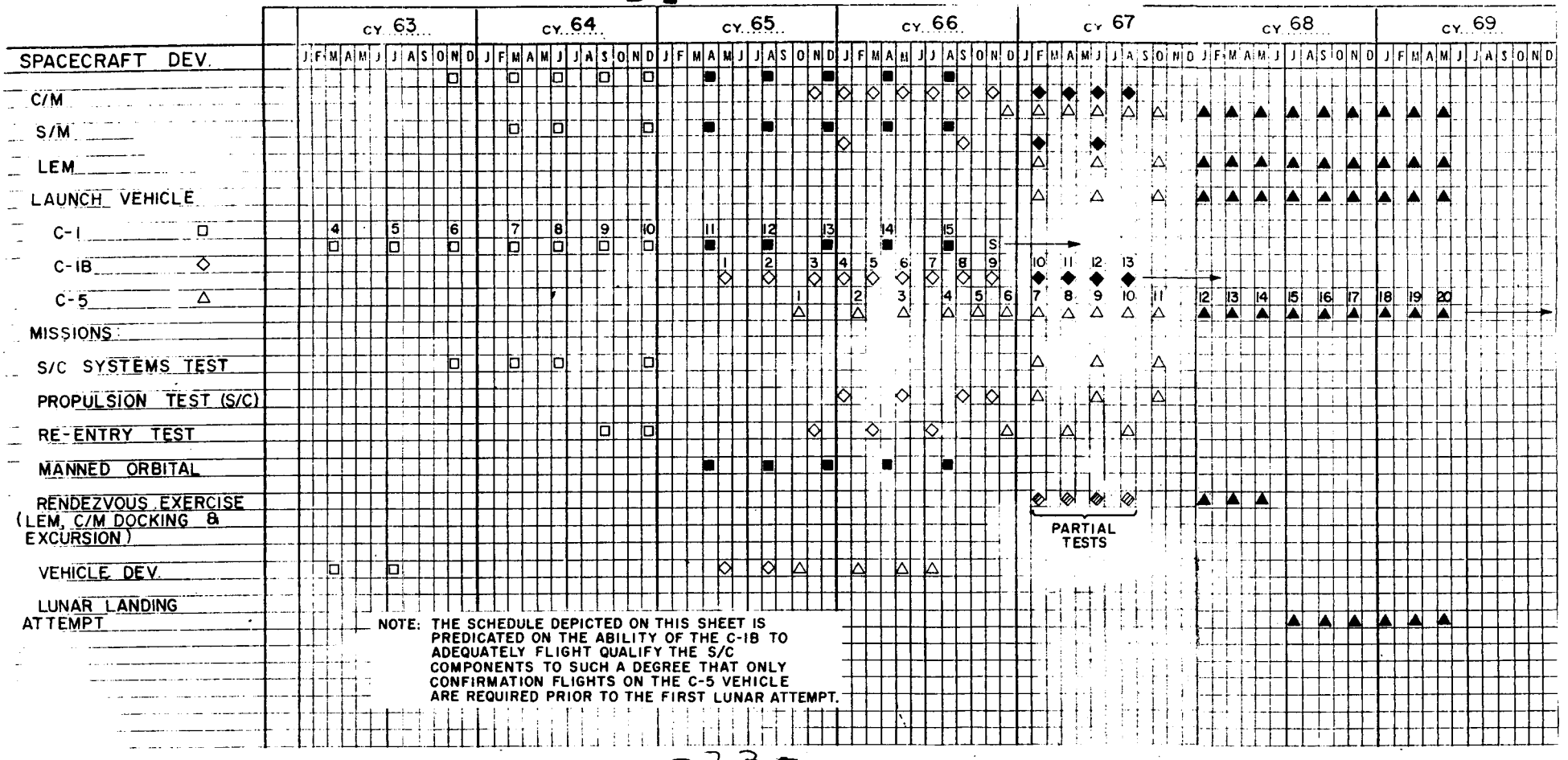
Copies of the revised schedules for various modes under consideration as well as a summary schedule for all the modes are included in Addendum C, Figures C1 through C4. In developing the revised schedules, common ground rules were used as far as possible; thus, the schedules are considered adequate for making relative time comparisons for the various modes under consideration. Although no attempt was made to include the lunar logistics vehicle or the RIFT programs in this exercise, they may be included in the revised schedules without affecting the relative time comparisons.

After selection of the primary mode, a detailed coordinated development plan, specifying individual missions, will be required to determine the quantity of R&D and operational vehicles needed for implementation of the manned lunar landing program.

TITLE LOR (C-1, C-1B & C5) (SEE NOTE)

C-1

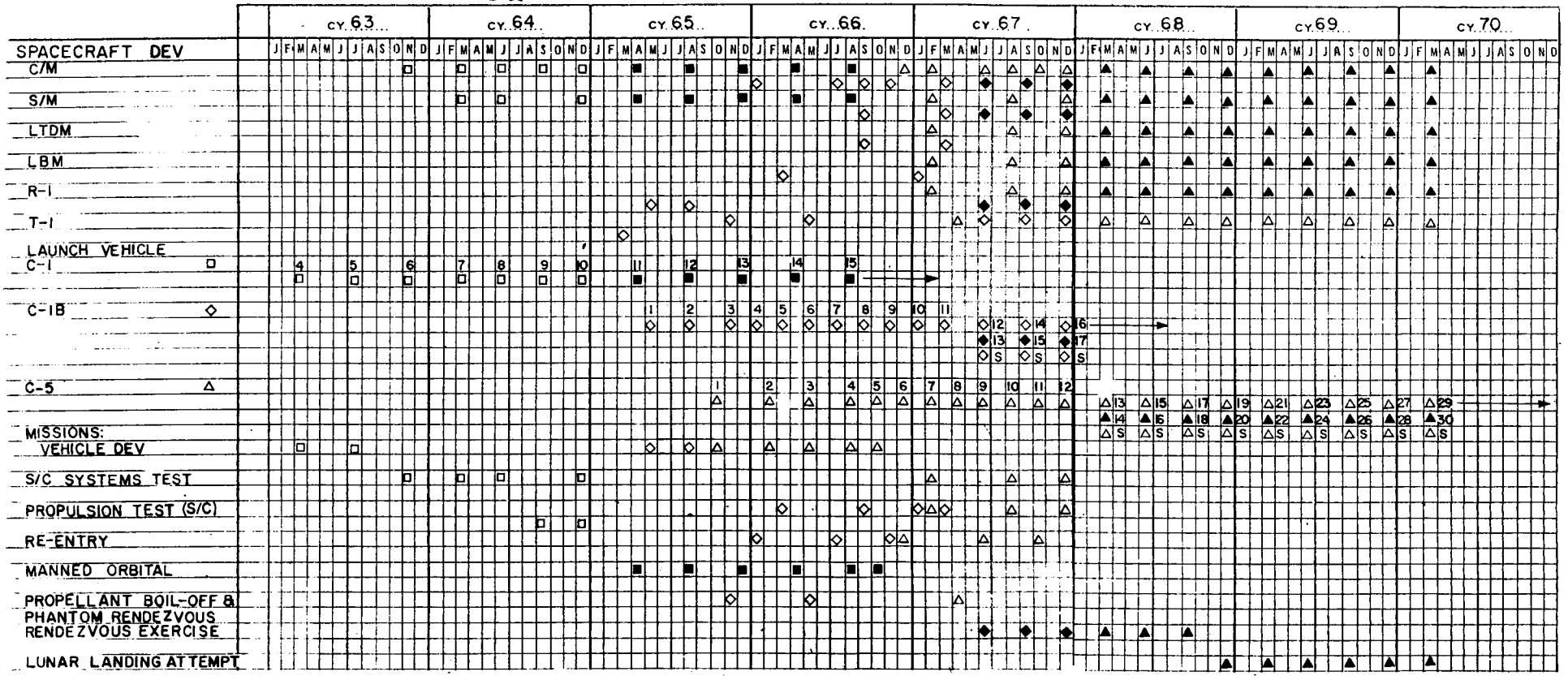
□ UNMANNED
■ MANNED



TITLE EOR (C-1 C-BI & C-5)

C-2

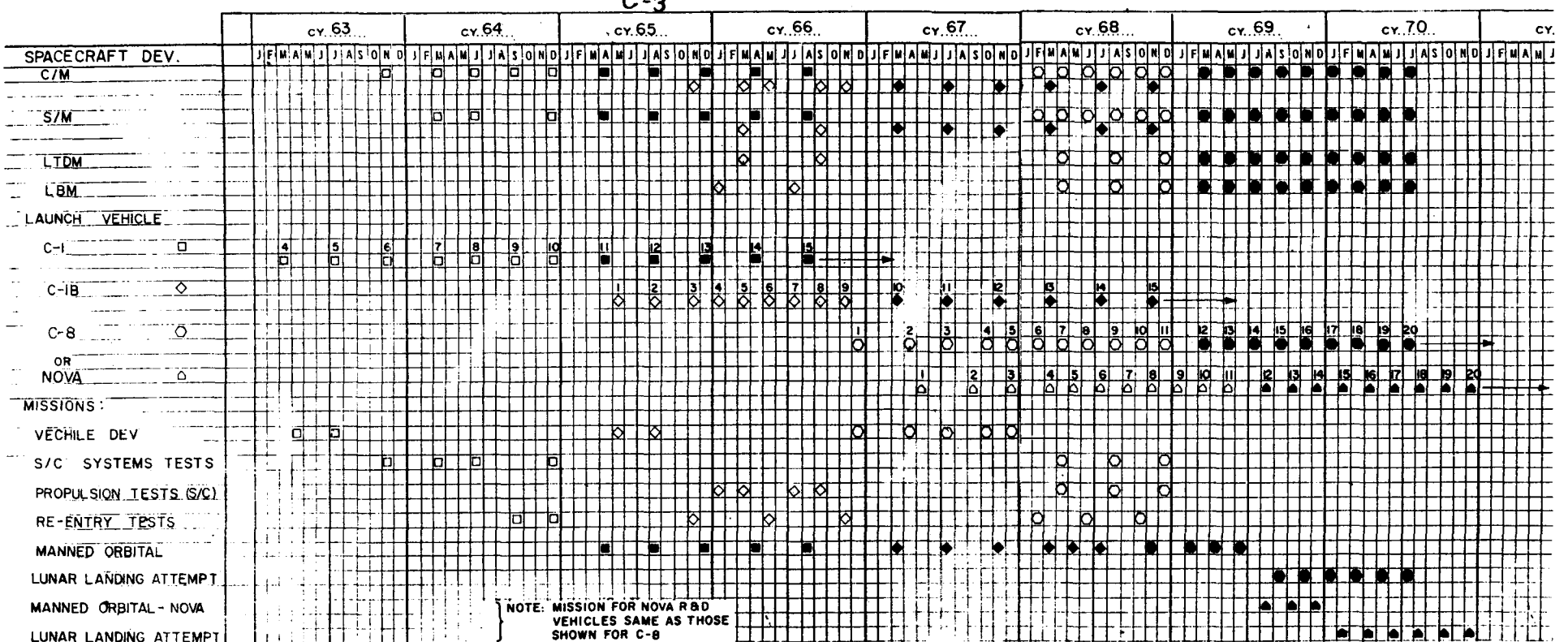
□ UNMANNED
■ MANNED



TITLE DIRECT (C-I, C-IB & C-8) OR (C-I, C-IB & NOVA)
REVISED

C-3

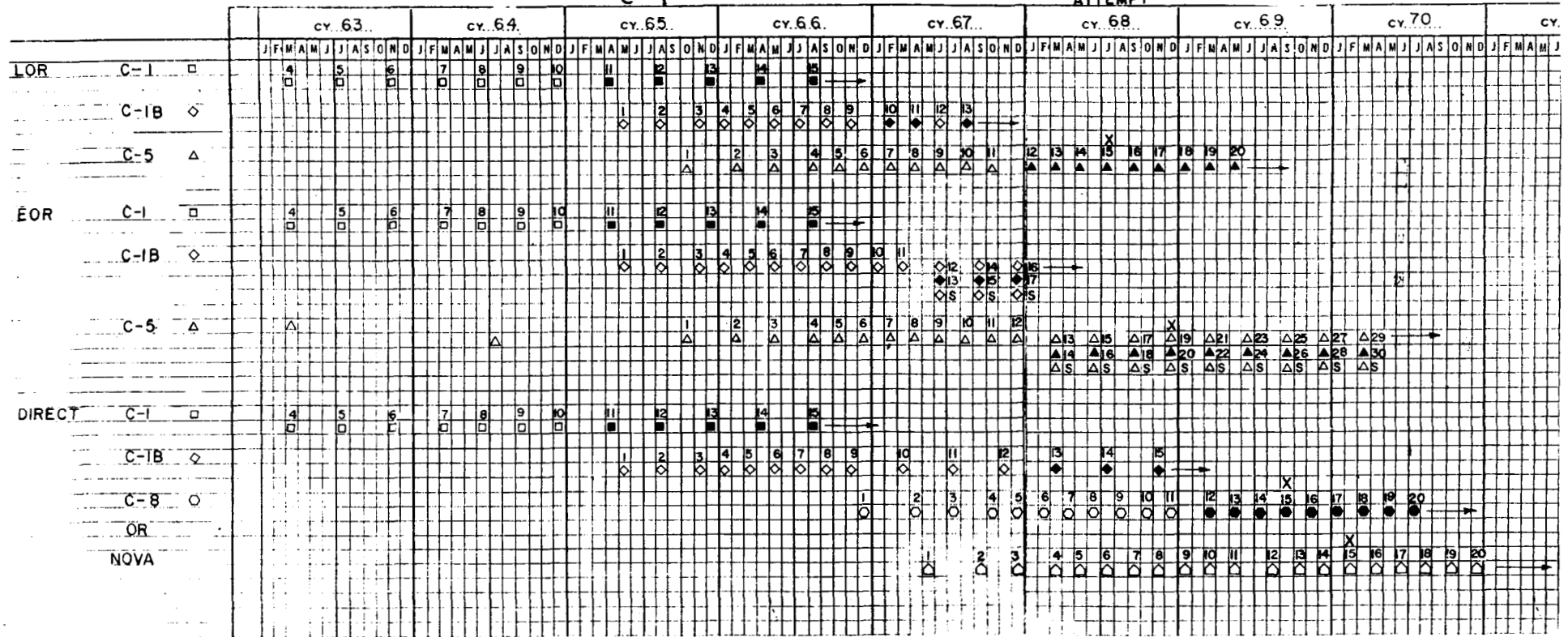
□ UNMANNED
■ MANNED



TITLE SUMMARY SCHEDULE
REVISED

C-4

□ UNMANNED
■ MANNED
X FIRST LUNAR LANDING ATTEMPT



ADDENDUM 3A - CENTER FUNDING FOR TOP SCHEDULES

In the following tables are shown summaries of the funding information supplied by MSFC, MSC and LOC in response to D. B. Holmes directive, dated May 25, 1962. Each of the Centers stressed the point that the time allowed for the preparation of the reports was entirely inadequate and that data and information furnished should be used for mode comparison only.

Prepared by MPRF
6/19/62

LUNAR ORBITAL RENDEZVOUS MODE

(IN THOUSANDS)

INSTALLATION	PROGRAMMED THRU FY-62	FY-63	FY-64	FY-65	FY-66	FY-67	TOTAL
MSC							
Development	64,800	430,000	350,000	165,000	105,000	17,850	1,132,650
Manufacturing	-0-	118,500	211,700	305,000	265,000	150,000	1,050,200
Operations	900	73,000	107,150	109,000	115,000	161,000	566,050
Total Direct R&D	65,700	621,500	668,850	579,000	485,000	328,850	2,748,900
Facilities	2,275	59,030	10,000	2,000	2,000	300	75,605
Total MSC	67,975	680,530	678,850	581,000	487,000	329,150	2,824,505
MSFC							
Vehicles Development	917,910	934,070	884,475	547,790	395,600	174,500	3,844,345
Operation of vehicles	-0-	78,300	112,200	218,200	89,600	36,000	534,300
Total Direct R&D	917,910	1,002,370	996,675	765,990	485,200	210,500	4,378,645
Facilities	170,104	207,637	67,350	3,750	3,250	2,250	454,341
TOTAL MSFC	1,088,014	1,210,007	1,064,025	769,740	488,450	212,750	4,832,986
LOC							
DIRECT R&D		43,500	78,000	60,000	60,000	60,000	301,500
FACILITIES		324,900	267,000	165,000	38,000	23,000	817,900
TOTAL LOC		368,400	345,000	225,000	98,000	83,000	1,119,400
SUMMARY							
DIRECT R&D	983,610	1,667,370	1,743,525	1,404,990	1,030,200	599,350	7,429,045
FACILITIES	172,379	591,567	344,350	170,750	43,250	25,550	1,347,846
TOTAL "LOR"	1,155,989	2,258,937	2,087,875	1,575,740	1,073,450	624,900	8,776,891

Prepared by MPRF
6/19/62

EARTH ORBITAL RENDEZVOUS MODE

(IN THOUSANDS)

INSTALLATION	PROGRAMMED THRU FY-62	FY-63	FY-64	FY-65	FY-66	FY-67	TOTAL
MSC							
Development	64,800	475,000	375,000	250,000	130,000	72,090	1,366,890
Manufacturing	— 0 —	81,500	228,700	300,000	226,000	122,000	958,200
Operations	900	73,000	107,150	109,000	115,000	161,000	566,050
Total Direct R+D	65,700	629,500	710,850	659,000	471,000	355,090	2,891,140
Facilities	2,275	59,030	12,000	2,000	2,000	300	77,605
TOTAL MSC	67,975	688,530	722,850	661,000	473,000	355,390	2,968,745
MSFC							
R+D and Operations	917,910	978,955	963,075	618,490	447,100	196,750	4,122,280
Operational	— 0 —	80,900	179,800	604,100	292,100	86,400	1,243,300
Total Direct R+D	917,910	1,059,855	1,142,875	1,222,590	739,200	283,150	5,365,580
Facilities	170,104	211,737	77,090	3,550	3,300	2,000	467,781
Total MSFC	1,088,014	1,271,592	1,219,965	1,226,140	742,500	285,150	5,833,361
LOC							
DIRECT R+D		43,500	78,000	60,000	60,000	60,000	301,500
FACILITIES		324,900	267,000	165,000	38,000	23,000	817,900
TOTAL LOC		368,400	345,000	225,000	98,000	83,000	1,119,400
SUMMARY							
DIRECT R+D	983,610	1,732,855	1,931,725	1,941,590	1,270,200	698,240	8,558,220
FACILITIES	172,379	595,667	356,090	170,550	43,300	25,300	1,363,286
TOTAL "EOR"	1,155,989	2,328,522	2,287,815	2,112,140	1,313,500	723,540	9,921,506

Prepared by MMF
6/19/62

DIRECT FLIGHT MODE

(IN THOUSANDS)

INSTALLATION	PROGRAMMED THRU FY-62	FY-63	FY-64	FY-65	FY-66	FY-67	TOTAL
MSC							
Development	64,800	475,000	375,000	250,000	130,000	71,690	1,366,490
Manufacturing	— 0 —	81,500	278,700	320,000	226,000	122,000	1,028,200
Operations	900	73,000	107,150	109,000	115,000	161,000	566,050
TOTAL DIRECT R&D	65,700	629,500	760,850	679,000	471,000	354,690	2,960,740
Facilities	2,275	59,030	12,000	2,000	2,000	300	77,605
TOTAL MSC	67,975	688,530	772,850	681,000	473,000	354,990	3,038,345
MSFC							
R&D and Operations	868,702	870,500	1,067,555	888,520	538,760	261,250	4,495,287
Operational	— 0 —	78,300	90,200	231,770	182,670	52,000	634,940
TOTAL DIRECT R&D	868,702	948,800	1,157,755	1,120,290	721,430	313,250	5,130,227
Facilities	170,104	196,998	173,290	67,350	3,000	2,000	612,742
TOTAL MSFC	1,038,806	1,145,798	1,331,045	1,187,640	724,430	315,250	5,742,969
LOC							
DIRECT R&D		43,500	78,000	60,000	60,000	60,000	301,500
FACILITIES		231,400	258,000	241,000	32,000	24,000	786,400
TOTAL LOC		274,900	336,000	301,000	92,000	84,000	1,087,900
SUMMARY							
DIRECT R&D	934,402	1,621,800	1,996,605	1,859,290	1,252,430	727,940	8,392,467
FACILITIES	172,379	487,428	443,290	310,350	37,000	26,300	1,476,747
TOTAL "DF"	1,106,781	2,109,228	2,439,895	2,169,640	1,289,430	754,240	9,869,214

ADDENDUM 3B - CENTER FUNDING FOR REVISED SCHEDULES

The revised schedules shown in Addendum 2C were resubmitted to MSFC, MSC and LOC; a summary of the information supplied is shown in the following tables.

CONCLUSIONS

SCHEDULES

The top schedules, which were developed are optimistic success schedules, do not include consideration of the unreliability of the C-1, C-1B, C-5 or C-8 vehicles or the problems which surely will exist in the flight development of the spacecraft. These schedules are not intended to represent dates by which individual missions will be accomplished, but rather the dates by which mission hardware will be available.

The revised schedules take into account the comments made by MSFC, MSC and LOC and add a small number of spacecraft development flight tests. This revisions results in the following dates for the first manned lunar mission attempt for each mode.

LOR July 1968
EOR December 1968
C-8 Direct flight September 1969
Nova Direct flight February 1970

It is believed that "realistic" schedules which would include consideration of the reliability of the test vehicles and injection vehicles, and a complete flight development test program would result in the LOR and Nova Direct Flight modes being fairly close in time, with the LOR Mode being earliest, and the EOR Mode being considerably extended in time.

COST

The cost information which has been developed is not judged to reveal any significant difference in modes. This conclusion is arrived at largely because of the small differences shown, the adequacy of the schedules which were used as a base, and accuracy caused by the extremely short time given to the Centers in which to prepare the information.

CONFIDENTIAL

REVISED SUMMARY BASED ON
CENTER ESTIMATES OF
HARDWARE CAPABILITIES

LUNAR ORBITAL RENDEZVOUS MODE (In Thousands)

INSTALLATION	Programmed Thru FY 1962	FY 1963	FY 1964	Total Program Through 4 Manned Lunar Attempts
MSC				
Total Direct R&D	65,700	621,500	725,000	2,974,900
Facilities	2,275	59,030	10,000	75,605
Total MSC	67,975	680,530	735,000	3,050,505
MSFC				
Total Direct R&D	747,910	739,270	876,175	4,557,228
Facilities	170,104	207,637	67,350	457,391
Total MSFC	918,014	946,907	943,525	5,014,619
LOC				
Direct R&D	-------	43,500	78,000	336,500
Facilities	-------	321,400	267,000	828,400
Total LOC	-------	364,900	345,000	1,164,900
Summary				
Direct R&D	813,610	1,404,270	1,679,175	7,868,628
Facilities	172,379	588,067	344,350	1,361,396
Total LOR	985,989	1,992,337	2,023,525	9,230,024

CONFIDENTIAL

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REVISED SUMMARY BASED ON
CENTER ESTIMATES OF
HARDWARD CAPABILITIES

EARTH ORBITAL RENDEZVOUS MODE (In Thousands)

INSTALLATION	Programmed thru FY 1962	FY 1963	FY 1964	Total Program through 4 Manned Lunar Attempts
MSC				
Total Direct R&D	65,700	629,500	750,000	2,976,140
Facilities	2,275	59,030	12,000	77,605
Total MSC	67,975	688,530	762,000	3,053,745
MSFC				
Total Direct R&D	747,910	776,970	946,475	5,828,378
Facilities	170,104	211,737	77,090	470,831
Total MSFC	918,014	988,707	1,023,565	6,299,209
LOC				
Direct R&D	-------	43,500	78,000	376,500
Facilities	-------	321,400	267,000	851,400
Total LOC	-------	364,900	345,000	1,227,900
Summary				
Direct R&D	813,610	1,449,970	1,774,475	9,181,018
Facilities	172,379	592,167	356,090	1,399,836
TOTAL EOR	985,989	2,042,137	2,130,565	10,580,854

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REVISED SUMMARY BASED ON
CENTER ESTIMATES OF
HARDWARD CAPABILITIES

DIRECT FLIGHT MODE (In Thousands)

INSTALLATION	Programmed thru FY 1962	FY 1963	FY 1964	Total Program through 4 Manned Lunar Attempts
MSC				
Total Direct R&D	65,700	629,500	750,000	3,424,740
Facilities	2,275	59,030	12,000	77,605
Total MSC	67,975	688,530	762,000	3,502,345
MSFC				
Total Direct R&D	702,602	554,670	700,575	5,243,570
Facilities	170,104	162,032	179,315	615,852
Total MSFC	872,706	716,702	879,890	5,859,422
LOC				
Direct R&D	-------	43,500	78,000	436,500
Facilities	-------	231,400	138,000	840,400
Total LOC	-------	274,900	216,000	1,276,900
Summary				
Direct R&D	768,302	1,227,670	1,528,575	9,104,810
Facilities	172,379	452,462	329,315	1,533,857
TOTAL DIRECT FLIGHT	940,681	1,680,132	1,857,890	10,638,667